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The Benefits of Perceived Ease of Use and Usefulness in Multi-Site Videoconferencing

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Abstract
Multi-site videoconferencing offers participants a communication medium that simulates in-person encounters without copresence. The group dynamics of virtual teams using this forum are innately different. Previous research on ways to improve interaction among groups using videoconferencing has identified various enabling factors. This paper puts forth results that to our knowledge have not been documented before - the benefits of perceived ease of use and usefulness of multi-site videoconferencing technology on group communication.

1 Introduction
Videoconferencing is an information and communication technology with great potential for uniting team members dispersed across locations. It allows them to communicate with each other through audio and video in real time and work together on tasks.

We conducted a study exploring the functioning of five virtual health administration groups who met via multisite videoconferencing. This paper discusses the study findings about the relationship between core constructs in Davis' Technology Acceptance Model (TAM) - perceived usefulness of the technology and perceived ease of use – and factors related to group dynamics.

Our health authority partner in this study, located in New Brunswick, one of the most rural provinces in Canada, served 166,000 citizens over a geographic region of 23,251 kilometers. In total, 15 communities and five First Nation communities were included in the organisation's catchment area. The dispersed health centres over the large area has led to telehealth becoming a popular mechanism for health region staff to communicate. Due to the busy schedules of staff and limited human and financial resources, it is not always possible to travel to the urban centre where most of the trainings and committee members are located. In the health region's 2008 User Impact Survey, 53% of videoconference user respondents indicated that videoconferencing gave them better access to educational events and training, and more than 60% noted that they had become more involved in professional activities and committees because of

videoconferencing.

A technology by itself will not provide high quality communication between group members; instead, it is the interaction among individuals and between the group and the technology that contributes to the success of the communication. Our research team has developed an analytic framework for analyzing broadband visual communication (O'Donnell, Molyneaux & Gibson, 2009). The framework emphasizes the importance of considering all types of facilitators and constraints to communication. The interaction of users and groups with the technical infrastructure, as well as social and organizational relations, are key to understanding participation and engagement in videoconferences.

Therefore, it is important to understand how a range of factors operate within groups using the technology, and to study what factors are related to and predictive of each other. This study explored how perceived usefulness and perceived ease of use of the technology interacted with the group dynamics of the videoconference, and the impact on the outcome or success of the event. Perceived usefulness and perceived ease of use have received a good deal of attention in research that has attempted to understanding technology use and adoption. Interestingly, there is no research these authors are aware of that explores how these two constructs (originally posited by Davis, 1989) are related to group dynamics and the success of the communication offered by the technology.

2 Technology Acceptance Model

The Technology Acceptance Model (TAM), originally posited by Davis in his 1986 dissertation, states that an individual's use and acceptance of a technology is primarily influenced by their perceived usefulness of that technology and their perceived ease of use. The model has received extensive attention and has been used in numerous studies that typically look at use of a technology within an organization; it is considered a very robust theory for understanding technology use and acceptance by individuals (Lee, 2003).

As evidence of that, recent research presented in the 2008 Canadian Society of Telehealth conference demonstrated that the TAM model is still one of the most popular theories on technology adoption and attitudes toward technology use (Mezni et al., 2008). These researchers, attempting to identify the most popular theories for health technology adoption and use, reviewed over 4,700 articles and narrowed down their count to 19 articles. The TAM was found to be the most widely used model for studying telemedicine use by health care professionals; these studies have often even included physicians as participants to authentically study the user group.

It therefore seemed appropriate to use the TAM constructs in our study of multi-site videoconference users within the health organisation, as we wanted to further understand their perceptions on the technology, and what was

contributing to their desire to use it. The goal of the larger project was to learn about what contributed to successful participatory multi-site videoconferencing, and the TAM definitely seemed to contribute theoretical understanding.

To elaborate further on the constructs involved, perceived usefulness refers to how useful and helpful the user thinks the technology is for herself or for her group and how well she judges it can carry out necessary tasks. Perceived ease of use relates to how comfortable they are using the technology and whether they think that a lot of effort is required in using it or not. It makes sense that users who find the technology useful and easy to use are positioned better to have a successful experience with it. Further, the two constructs have been found to be related to each other (Davis, 1989); those who perceive the technology to be useful are also likely to perceive it as easy to use.

Previous research on the use of multisite videoconferencing (using desktop systems) has also found it useful to include TAM like questions in their analysis. Within a setting similar to that in our own study, Meyer (2008) reports on the use of a desktop system by administrators in a health setting over a few months. Results indicated that the users perceived the technology to be useful, and their productivity actually seemed to be enhanced. In addition, on average participants reported feeling comfortable with the technology. The drawbacks of using the technology included perceptions of less social presence than face to face meetings, and less human contact.

Videoconferencing is a technology where social presence and feelings of social connection could greatly influence one's experience, and so it was important to take these into account along with the TAM constructs in this study. Past research has examined the TAM model and its relation to certain social connection variables, specifically, social presence. Social presence is the feeling of awareness of the other person in the communication (Short, Williams, & Christie, 1976), and it is said to range from limited in text communication, to heightened in face to face communication. In one study of people's use of a robot, researchers found that social presence was correlated to the person's intention to use the robot – and the more enjoyment they received from the interaction with the robot, the more likely they would want to use the technology again (Heerink et al., 2008). Another study that used TAM for understanding online shopping webistes also investigated the role of social presence (Hassanein & Head, 2007). Results indicated that social presence was positively related to perceptions of usefulness of the technology, along with enjoyment of the technology and trust in it.

Numerous studies have looked at the TAM model in a larger organizational and social context, examining the influence of gender and culture, for example, on the TAM model. Further, the relationships between several external variables and the TAM constructs have been studied in depth – such as analyzing TAM and computer anxiety, prior experience, and management support, among others.

Never before has TAM been examined in relation to group dynamics for videoconferencing. This is important to look into because in successful multi-site videoconferencing, the perceptions of the users on the technology, as well as their interactions with the technology and their interactions with each other, are going to be key.

3 Multi-site videoconferencing

Multi-site videoconferencing is a communication process requiring both technology and participants in multiple locations. The design attributes of the technology and the behaviour of the user both determine the viability of the technology (Cool *et al.,* 1992). Technology alone does not guarantee successful videoconferencing; for example, studies on desktop videoconferencing systems conclude that the access to videoconferencing alone was not sufficient to encourage interactivity - participants using videoconferencing interacted with the technology according to pre-established social norms that were critical in determining how the videoconferencing system was used (Fish *et al.,* 1992).

To increase awareness and encourage videoconference use, videoconference systems have to be easy to use. The way people view the technology will affect their use of the videoconferencing system. The way people see the remote locations, and see their own image, are potential hindrances to participation (Molyneaux *et al.,* 2007).

While technology is an important variable for participation, good group relationships are needed in order to maximize the participatory potential of a multi-site videoconference (Molyneaux *et al.,* 2008). A good team will overcome technological problems; however, good technical support paired with poor team dynamics makes virtual teamwork very difficult (Jarman, 2005).

The group dynamics also affects how users perceive and utilize technology. Group dynamics include the development of trust, the critical mass of users, and group norms and size.

The development of trust is a critical success factor for groups working via videoconferencing (Mankin, Cohen & Fitzgerald, 2004; Sonnenwald, *et al.,* 2002; Wainfan & Davis, 2004; Anderson, 2006; Mansour-Cole, 2001; Jarvenpaa & Leidner, 1998; Rutkowski *et al.,* 2002; Nemiro, 2000). Because eye contact is difficult to maintain and body language and gestures are difficult to interpret in multi-site videoconferences, building trust in virtual teams can be challenging and time consuming (Molyneaux et al., 2008). Large group multi-site meetings can take more time because of the need for more verbal acceptance, which could mean less time for relationship building (Anderson, 2006; Jarvenpaa & Leidner). When individuals have not worked together, or are meeting only once trust can also be inhibited (Jarvenpaa & Leidner).

The number of users in the implementation stage of a technology determines critical mass; this number will indicate the success or failure of a new technology (Kraut *et al.,* 1994). If people perceive technology as useful and easy to use it will be used more often and the number of users will increase.

Researchers have found that cultural and social influences affect group decision-making. For example some cultures have a collectivist outlook consisting of tight-knit social networks; these cultures are more willing to adhere to group norms than other cultures that believe individuals are responsible for themselves (Gou, Turner & Tim, 2006). Social influences also affect attitudes, behaviors and perceptions of people vis-à-vis new technology. Based on the idea that individuals want to conform to others' expectations, the theory of social influence posits that members conforming to group norms will have similar perceptions of new technology (Gou, Turner & Tim). Over time groups can develop their own norms about technology that may affect how they perceive technologies ease of use and usefulness (Gou, Turner & Tim).

The group dynamics that may be operating within a multi-site videoconference are likely multi-layered. In larger multi-site meetings opportunities for individual participation may be limited because of fewer opportunities for interactivity and reciprocity (Blignault, 2000; Roberts, Lowry & Sweeny, 2006). Larger groups may have more participants from different backgrounds than do small groups; the potential for knowledge discrepancies may increase, creating a negative affect on participation (Anderson, 2006). Finally, in large group multi-site videoconferences participants may feel they have limited authority in group decision-making (Shaw *et al.,* 2004).

4 Study method

Participants in our study included 45 multi-site videoconference users who worked in a hospital setting. They completed a five-page survey on demographics, social factors, and technical factors. Items measuring the perceived usefulness and ease of use of the technology were adapted from Davis' original items for assessing these constructs. Data was collected at five different videoconference events.

4.1 Research questions

Our study had three main research questions:

- How are perceived usefulness (PU) and perceived ease of use (PEU) operating within the virtual groups?
- How are PU and PEU related to feelings of social connection within the virtual groups?
- What factors predict PU, PEU, and feelings of social connection?

4.2 Participants

Five health administration groups who meet on a regular basis via multi-site videoconferencing were recruited to participate in this study. Three of these

groups were administrative, and most of their tasks focused on committee work. The members typically had a specified role for that committee. The other two groups were educational; these groups focused on professional development for health authority staff. These were open groups where anyone was welcome to attend any session, and there was no official group membership.

Participants were from four different sites in total. Only 17.8% of participants identified as being from a rural site. The sample was mostly female, at 93%. This skewed distribution for gender could be accounted for by there being more females than males at all the videoconference events; in general there are more women in many health professions (e.g. nurses). English was the first language (88.9%) of most participants, French for 6.7% and other languages for 4.4%. The majority of survey respondents (64.4%) were between the ages of 36 and 55.

Average length of group membership was 20.88 months, however, most of the participants at the educational events did not identify as being part of a group – again this group was considered to be ad-hoc.

4.3 Materials

The questionnaire was in paper and pencil format and was five pages long. The survey contained questions on demographics, personal technology use, social factors, and technical factors, as well as questions on previous videoconference training. Items measuring the perceived usefulness and ease of use of the technology were adapted from Davis' original items for assessing these constructs.

4.4 Procedure

Following the administrative or educational videoconference session, participants were asked to complete the questionnaire. Surveys were available at all videoconference sites within the multi-site event. Participants were given a consent form to sign, and if they so wished they continued on to complete the questionnaire. Participant was voluntary and anonymous, and in total took about 10 minutes. Participants were treated in accordance with APA ethical guidelines.

4.5 Participatory approach and challenges

The researchers took a participatory, user-centered approach for this study. Throughout the entire process, from project conception through the ethics application, data collection, analysis and report-writing, the partners have been involved in determining the direction and process of the project. This method proved to be invaluable because it allowed the goals and outcome of the project to be tailored to our specific user group – the multi-site videoconference users in the health authority.

Like all methods, this approach was not without its shortcomings. There were several obstacles that the researchers encountered during the project. These were described in detail elsewhere (Gibson and O'Donnell, 2008) but they will be

summarized here to provide contextual details on the study and its procedure. The main challenges included going through ethics, the development of instruments (e.g. minimizing length of survey but maximizing quality of data collected), recruitment, the data collections, and finally a lack of stability in the work environment.

5 Study results

Statistical analyses of the data, via bivariate correlations and multiple regression analyses, helped us examine the relationships between the variables of interest and social dynamics. Both perceived ease of use and perceived usefulness were identified as related to, and predictive of, feelings of social connection.

5.1 Mean scores for social variables and TAM constructs

All of the social variables and tam constructs were measured on a 5 point scale – from 1 (strongly disagree) to 5 (strongly agree). The means for the various TAM items and the TAM scale scores overall, along with the social connection items and its overall score, will be reported.

Perceived ease of use of MSV. The mean score for *multi-site videoconferencing (MSV) technology is easy to use* was 3.56. *Comfort using the remote control* had a mean of 3.49. The mean score for *I find it easy to get the multi-site videoconferencing technology to do what I want it to do* was 3.19. When asked if using the technology did not require a lot of mental effort, the mean score was 3.28. Participants' scores across all of the PEU variables were averaged to form a PEU score, the mean score was 3.37.

Perceived usefulness of MSV. The mean score for *multi-site videoconferencing is useful for communication* was 4.40. Participants said the technology enabled their group to accomplish things more quickly (M=4.29) and improved the performance of the group (M=3.8). The average overall PU score was 4.16.

Feelings of group connection. The mean rating on *I felt like I belonged to a group* was 4.27. The mean score for whether the respondent was comfortable sharing their ideas and thoughts with people was 4.40. The mean rating for *a warm and friendly environment for communication was created* was 4.24. Participants were asked if they thought their site and the other sites actively communicated with each other during the multi-site videoconference; the mean response was 4.00. The lowest mean score was for *impression of personal contact with people at the other sites* (3.73). The average overall Social Connection score was 4.12.

Prior videoconference training. 26.7% of survey respondents had taken the training on videoconferencing offered by the site coordinators at the health organizations.

General use of technologies. Participants were asked to rate their use of

various technologies on a 7 point scale from never to almost everyday. An average score of technology use was formed based on their responses and the mean score of this technology use variable was 1.57.

Opportunity to contribute to the session. Participants were asked to rate on a 4 point scale 1(poor) to 4 (excellent) their opportunity to contribute during the videoconference, the mean score for this was 3.73.

5.2 Use of PCA to justify combining and averaging of items to create factors

A principal components analysis (PCA) is a statistical method that allows examination of how different items on a questionnaire load onto underlying components or constructs. In order to verify whether it was statistically appropriate to have combined all of the 5 social connection variables and averaged them out to make a mean social connection score, like with the PEU variables and the PU variables, a PCA was required.

The PCA for the social connection variables revealed that one component/one factor accounted for 65.22% of the variance across the five included items. All of the components loaded between .64 and .87 on the one factor.

The PCA for the Perceived Ease of Use variables found that one component accounted for 79.75% of the variance across the four included items. Loadings ranged from .87 to .92.

Finally, the PCA for Perceived Usefulness also found a one factor solution. One component accounted for 69.78% of the variance across the three items. The loadings for these items on the one component ranged from .74 to .89.

In sum, all of these statistical analyses support and justify the combining of the items to form these underlying constructs.

5.3 Bivariate correlations of social variables and TAM constructs

Bivariate correlations were performed on the three factor variables of interest, along with other variables which had been measured and seemed relevant to this analysis.

Perceived Usefulness. This factor was found to be significantly correlated with two other variables, including Perceived Ease of Use (r=.33, p=.03), and Social Connection (r=.38, p=.01).

Perceived Ease of Use. Two variables were significantly correlated with PEU, including Perceived Usefulness (r=.33, p=.03), and having received the health authority's videoconferencing training (r=.54, p=.00).

Social Connection. This factor was significantly correlated with several other

variables, including Perceived Usefulness (r=.38, p=.01), the number of videoconference events attended in the past six months (r=.38, p=.01), having received the vc training (r=.30, p=.05), and opportunity to contribute during the vc (r=.53, p=.00).

5.4 Regression results looking at the prediction of social connection and how the TAM variables contribute to prediction

A linear regression was performed on the two TAM factors and on the Social Connection factor in order to identify what predicted and accounted for most of the variance in these constructs. All variables were entered on the same step, and their inclusion in the regression model was based on whether they appeared to have a significant relationship with that variable (determined from the bivariate correlation matrix).

Regression for Perceived Usefulness. Two variables, PEU and Social Connection were entered into the regression equation for Perceived Usefulness. Together they predicted almost 20% of the variance in Perceived Usefulness (R=.44, R Square =.196, Adjusted R Square =.156) and this was statistically significant at the p=.01 level. The Standardized Beta Coefficient values were .25 for PEU (p=.11) and .31 for Social Connection (p=.05). This means that Social Connection is the better predictor of Perceived Usefulness, and accounts for more variance in PU than PEU does, though there is a trend for PEU to be predictive of PU.

Regression for Perceived Ease of Use. Two variables – Perceived Usefulness, and health authority vc training, were entered into this regression equation. This model accounted for a fair amount of variance in PEU (R=.61, R Square=.37, and Adjusted R Square=.34) and was significant at the p=.00 level. Both variables were significant predictors of PEU, with PU having a standardized beta value of .273 (p=.04), and the vc training having a beta value of .51 (p=.00).

Regression for Social Connection. Several variables were entered into the regression equation for Social Connection, these included the participants rating of their opportunity to contribute during the videoconference, Perceived Usefulness, videoconference training by the health authority, and number of vc events attended in the last six months. This model accounted for a good amount of variance – R=.68, R Square=.46, and Adjusted R Square=.41, statistically significant at the .00 level. However, not all variables were significant predictors – the two variables with the highest standardized betas were Perceived Usefulness (β=.33, p=.01), and rating of opportunity to contribute to the vc (β=.42, p=.00).

6 Discussion

This study explored how the two constructs of the Technology Acceptance Model - Perceived Ease of Use (PEU) and Perceived Usefulness (PU) - were operating within this user group, and how they related to feelings of social connection

during the videoconference. In addition to uncovering the correlations among the variables in question, we wished to identify which variables were the best predictors of Perceived Usefulness, Perceived Ease of Use, and feelings of Social Connection. Having this information can help direct interventions and aid in recommendations for future use and ways to increase these feelings which are all a part of successful participatory videoconferencing.

Overall, participants perceived the multi-site videoconferencing technology to be useful for communication and enabling their group to accomplish things more quickly. Participants also tended to see the technology as fairly easy to use, though their ratings of the usefulness of the technology was higher. As expected, a significant positive relationship was found between PU and PEU. This replicates previous research findings (Davis, 1989, and others) and means that participants who perceived the multi-site videoconferencing to be useful for their group and for communication also perceived the technology to be easy to use. Perceived Usefulness was also found to be correlated with feelings of Social Connection – meaning that those who rated the videoconference environment as warm and those who felt part of a group and who had positive feelings of social connection were also more likely to perceive the multi-site videoconferencing technology to be useful for communication. Furthermore, PEU was found to be significantly correlated with videoconferencing training.

What predicted PU, PEU, and the feelings of social connection? To answer the first question, variables which were correlated with PU were entered into a linear regression, in order to identify which variables helped significantly predict PU among the participants. Interestingly, feelings of social connection was the only significant predictor, though there was a trend for perceptions of ease of use of the technology to be predictive of PU. Similar to previous research that examined social presence in the context of other technologies (Hassanein and Head, 2007; Heerink et al., 2008) (videoconferencing had not been studied along with social presence in TAM research), we also found that feelings of social connection are strongly linked to, and predictive of, perceived usefulness.

Perceived ease of use was significantly predicted by the participants' perceptions of the usefulness of the technology, along with whether they had received the videoconferencing training offered by the site coordinators. This first predictor is not surprising, as we know from the existing body of TAM research that there is a correlation between PEU and PU (Davis, 1989). The interesting finding here is the power of the training to increases users ability to interact with the technology and to perceive the technology as being easy to use. This seems to speak to the need for more participants to be trained, as less than 30% had received the training, yet this was found to be a significant predictor of PEU. At the same time, during the correlational analysis it was verified if there was a significant relationship of having seen the videoconferencing checklist and PEU. The videoconference checklist is a sheet of videoconferencing tips and reminders that is placed in each telehealth room. The correlation between PEU and having seen

the checklist was not statistically significant. Therefore, the more comprehensive training appears to have been more effective, at least in terms of increasing PEU.

Finally, the predictors of feelings of social connection included perceived usefulness, and the participants' rating of opportunity to contribute. This demonstrates the interaction between a user and the technology, and the user and their environment, and how it can affect the overall group dynamics. Perhaps if a participant finds the technology to be useful, they will be more likely to engage with it (as PU predicts PEU) and consequently their ability to communicate with others and their feelings of social connection improve. The finding that opportunity to contribute significantly predicts feelings of social connection speaks to the importance of inclusion during videoconferences. Ensuring that all sites interact with each other and are given the opportunity to provide feedback and contribute to discussions is key to participatory videoconferencing.

This is the first study to explore TAM and feelings of social connection in videoconferencing, and it is not without its limitations. The sample size was not very large and at the same time not very diverse (e.g. gender distribution). Therefore, it will be necessary to replicate this study's findings in future research in order to validate the results. Future researchers who are interested in communication technologies and participatory communication would benefit from studying TAM within the context of group dynamics. Furthermore, developing and validating a model that takes into account feelings of social connection, along with PU and PEU could be meaningful theoretically and practically, for it could more clearly delineate the connections between the variables and what influences what in the grander scheme of things.

7 Conclusions

The Technology Acceptance Model has typically been applied to study the predicted use of technology, however, this research demonstrates its utility in also helping to predict and understand group dynamics within virtual groups.

Interactions between users, and between users and the technology, helps shape the experience of a participatory multi-site videoconference. If users perceive the technology to be useful for communication and easy to use, and they find they can achieve a warm atmosphere for communication and good group dynamics they are likely to have a more participatory and successful communication experience. Interestingly enough, despite extensive previous research on the TAM model which looks at perceived usefulness and perceived ease of use in technology use, no research has ever explored these variables in the context of group dynamics for videoconferencing.

This paper explored the relationships between PU, PEU, and feelings of Social Connection within five virtual health groups who met through multi-site videoconferencing. These factors were also looked at in terms of their relation

with other variables of interest (training on videoconferencing, rating of opportunity to contribute during the videoconference). As expected, PU and PEU were found to be significantly related to each other. PU was also significantly related to feelings of Social Connection. Linear regressions were performed on the PU, PEU and Social Connection variables in order to identify the best, most significant, predictors of each. PU was best predicted by PEU and feelings of Social Connection. The variables that best predicted PEU included PU and having had videoconferencing training. Finally, PU and opportunity to contribute best predicted feelings of Social Connection.

What does all of this mean and how do all of these variables tie together? First and foremost, these findings underscore the importance of studying technology use within the social context and understanding how a technology that is being used might interact with the group dynamics.

Second, the finding that PEU and PU are significantly correlated lends further support to previous TAM findings.

Third, the fact that PU and feelings of Social Connection are related suggests that an individual who finds the technology useful is also likely to have a positive social experience and experience good group dynamics.

Fourth, experience of having an opportunity to contribute during a videoconference is likely to predict feelings of social connection – the more that individuals and sites can feel included and invited to participate, the better the group dynamics and success of the videoconference overall.

Finally, it can be concluded that staff training on using the technology can make a difference in their perceived ease of use, and thus also affect their perception of the usefulness of the technology, and can also increase the potential for better social connection during the session and more participatory videoconferencing.

8 Recommendations

Addressing and enhancing users' perceptions of perceived usefulness and ease of use of multi-site videoconferencing can facilitate group functioning and enhance group dynamics, creating a true participatory videoconferencing experience. A starting point is to first evaluate users' perceptions of the multi-site videoconferencing technology and then identify strategic ways forward to meet users' needs or address gaps.

Further education and promotion on the usefulness of multi-site videoconferencing could be necessary. Training on how to use the technology would obviously also be beneficial, as this study found. Training can be delivered at the start of a videoconference meeting so that all participants are receiving the same information to bring them up to speed, and the information can be specially tailored to the skills they will need for their specific videoconference. Only 27% of

the participants had received training; however having received the training made it more likely that they would perceive the technology to be easy to use, which was then related to PU, which was related to social variables, so training more individuals and increasing their knowledge and skills for videoconferencing is likely to have a ripple effect and improve their videoconferencing experience overall.

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